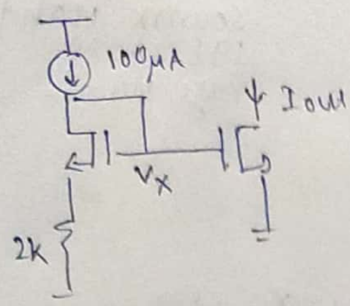
Sounak Mandal
19EC10088
Page No - 1

1. i)



$I_D = 100$

i) or $\frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_1 (V_{GS}-V_{th})^2 = 100$

or $\frac{1}{2} \times 200 \left(\frac{W}{L}\right)_1 (V_X - 0.2 - 0.4)^2 = 100$

or $100 \left(\frac{W}{L}\right)_1 (V_X - 0.6)^2 = 100$

or $\left(\frac{W}{L}\right)_1 (V_X - 0.6)^2 = \frac{100}{100} = 1$

Power dissipated by current source $= (3.3 - V_X)\,0.1$ mW
" " " R $= 0.1^2 \times 2 = 0.02$ mW

we want the power dissipated to be same

$\therefore 0.02 = 0.1\,(3.3 - V_X)$

or $0.2 = 3.3 - V_X$

or $V_X = 3.1$ V (Ans)

ii) $\left(\frac{W}{L}\right)_1 (V_X - 0.6)^2 = 1$

or $\left(\frac{W}{L}\right)_1 \times 2.5^2 = 1$

$I_{out} = \frac{1}{2}\mu_n C_{ox} \left(\frac{W}{L}\right)_2 (V_X - 0.4)^2$

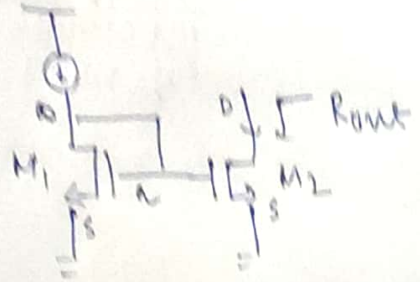
$= \frac{1}{\cancel{2}} \times 200 \times \cancel{2} \left(\frac{W}{L}\right)_1 \times 2.7^2$

$= 200 \times \frac{1}{2.5^2} \times 2.7^2$

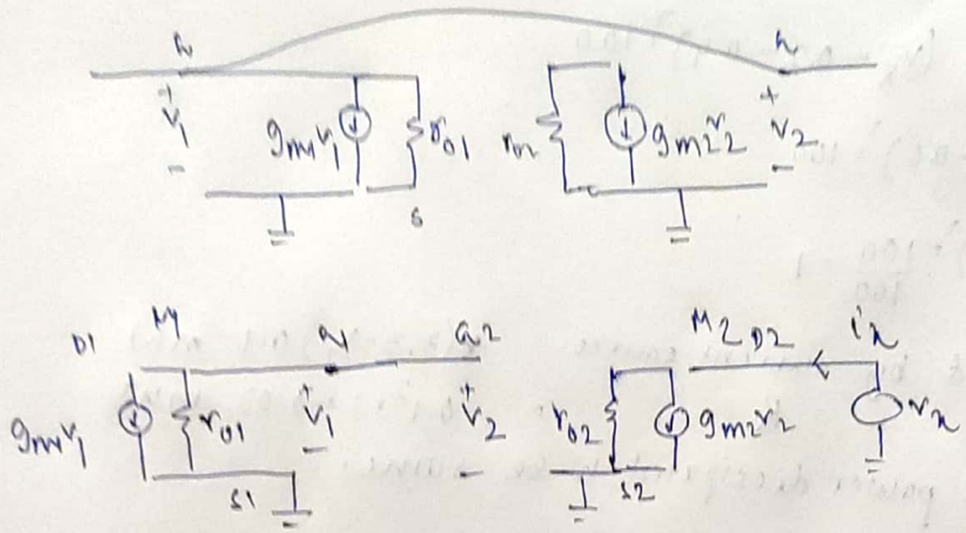
$= 233.28$ μA (Ans)

(i)

Sounak Mandal
19EC10088



From the concept of looking in we expect $R_{out} = r_{o2}$. For exact expression



$v_x = r_{o2}(i_x - g_{m2}v_2)$

$\frac{v_1}{r_{o1}} + g_m v_1 = 0$

or $v_1 \left(g_m + \frac{1}{r_{o1}}\right) = 0$

or $v_1 = 0$

$\therefore v_2 = 0$

$v_x = r_{o2} i_x$

or $\frac{v_x}{i_x} = \boxed{r_{o2} = R_{out}}$

$I_{ref} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_1 (V_G - V_{th})^2 (1+\lambda V_G)$

$I_{out} = \frac{1}{2}\mu_n C_{ox}\left(\frac{W}{L}\right)_2 (V_G - V_{th})^2 (1+\lambda V_{DS})$

$\therefore \frac{I_{out}}{I_{ref}} = \frac{1+\lambda V_{DS}}{1+\lambda V_G}$

or $I_{out} = I_{ref}\left(\frac{1+\lambda V_{DS}}{1+\lambda V_G}\right)$

or $I_{out} = \frac{I_{ref}}{1+\lambda V_G}(1+\lambda V_{DS})$

Sounak Mandal
19EC10088
Page No - 3

$\therefore I_{out} = \frac{I_{ref}}{1+\lambda V_a}(1+\lambda V_{DS})$

or $I_{out} = m V_{DS} + c$

$m = \frac{\lambda I_{ref}}{1+\lambda V_a}$

$c = \frac{I_{ref}}{1+\lambda V_a}$